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(54) Hydrophobic venting of free liquid ink reservoir pen.

(57) A pen containing free liquid ink in which the ink reservoir (2) is vented to atmosphere by use of hydrophobic material (14) whereby the pen is prevented from leaking ink through capillary vents or the like while having the pressure in the reservoir equalized with ambient air pressure by the hydrophobic venting material.

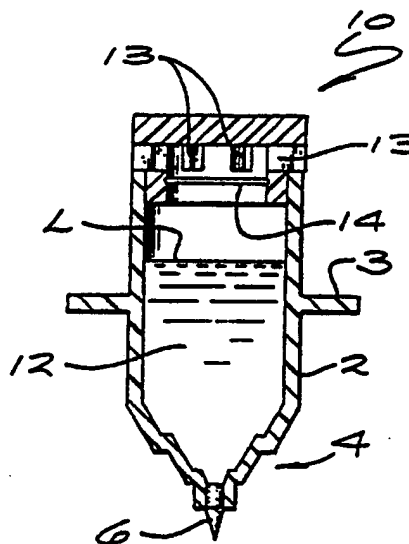


FIG. 1

EP 0 405 768 A1

HYDROPHOBIC VENTING OF FREE LIQUID INK RESERVOIR PEN

Background of the Invention and Prior Art

The present invention is directed to the field of relatively inexpensive disposable ink pens which use a self contained supply of liquid ink. Such pens are of widespread use wherever a continuous steady flow of ink is required and interruptions, i.e. "skipping" in the line drawn by the pen, cannot be tolerated. Such applications include, but are not limited to, computer driven plotter pens. The present invention is particularly concerned with a replaceable liquid ink pen useful as a plotter pen.

Prior art liquid ink pens have a sealed reservoir of liquid ink which is provided with a capillary or channel vent of small dimensions so as to prevent ink leakage through the capillary or channel vent. These pens deliver ink to a writing media from the tip of the pen via the capillary force of the pen nib and the media. As ink supply in the reservoir is depleted, the pressure in the reservoir drops until an air bubble forms at the interface between the reservoir and the vent. The bubble enters the reservoir and replaces the depleted ink with air, momentarily relieving the pressure difference. This process occurs throughout the life of the pen.

When the pen is not in use, its storage conditions may change. For example, the temperature of the ambient air may decrease causing the reservoir to cool with a resulting internal pressure drop which causes air to bubble into the reservoir. Subsequent temperature rises reverse the process and may cause movement of ink into the venting channel or venting capillaries if the orientation of the pen is such that the ink in the reservoir covers the end of the venting channel or capillaries. If the air expansion is sufficient, ink completely fills the venting channel or capillaries followed by leakage out of the pen. The same scenario occurs with decreases in ambient pressure.

One solution to the leakage problem is to use a fibrous filler in the liquid ink reservoir. Such fillers have an adverse effect on ink flow resulting in thin or uneven lines, particularly when the supply of ink is substantially depleted.

A major problem with using an air vent to control ink flow in free liquid ink reservoir pens is that different inks have different viscosities, and thus different sizes of vents are necessary to obtain identical flow rates for each different ink. One attempt to avoid this problem is disclosed in U.S. Patent No. 4,588,319 issued May 13, 1986 to Niemayer, which uses a foam flow restrictor positioned in the pen housing between the air vent and the main ink reservoir. Ink leakage to the outside of the pen through the capillary or channel vents due

to pressure differentials as discussed above, is not, however, provided by the foam flow restrictor.

5 Summary of the Invention

It is accordingly the object of the invention to provide a substantially leakproof free liquid ink reservoir pen.

10 The present invention accordingly provides a free liquid ink reservoir pen comprising:

- a) a reservoir containing a supply of liquid ink;
- b) a pen nib attached to said reservoir for delivering ink from said supply thereof to a writing medium;
- 15 c) a vent for venting said reservoir to atmosphere; and
- d) a body of hydrophobic venting material arranged to prevent the flow of ink from said reservoir through said vent to atmosphere, said hydrophobic venting material permitting air flow into and out of said reservoir through said vent to compensate for pressure differentials between the ambient atmosphere and the interior of said reservoir.

20 Unlike capillary and channel vented pens, air flow to vent the reservoir is not restricted by bubble generation. Air venting of the pens disclosed herein does not regulate ink flow since the reservoir is essentially open to atmosphere.

Brief Description of the Drawing

35 In the drawings wherein like reference numerals designate like parts:

Figure 1 is an elevation view in cross section of a first embodiment of the invention showing the pen in its vertical writing position;

40 Figure 2 is a top plan view of the embodiment shown in Fig. 1;

Figure 3 is a view similar to Fig. 1, of a second embodiment of the present invention showing a vented bottom reservoir wall;

45 Figure 4 is a vertical cross sectional view taken at lines 4 - 4 of Fig. 3;

Figure 5 is an elevation view in cross section of a third embodiment of the invention showing the pen in an inverted position; and

50 Figure 6 is a graph comparing the ink flow characteristics of the present invention with those of the prior art.

Description of the Preferred Embodiment

Figures 1 and 2 show an elongated pen reservoir body 2 of cylindrical configuration having a retaining collar 3 and a tapered tip portion 4 provided with a porous or hollow pen nib 6 centrally mounted therein. The upper end of the reservoir body 2 is preferably closed by a vent cap 10 which is press fit into the upper end of the reservoir body 2 to define an ink chamber 12 therein. The reservoir body 2 is conveniently made of clear plastic material so that the color and amount of the ink therein is easily determined.

The upper end of the reservoir body 2 has a vent in the form of one or more radially distributed vent passageways 13 and a piece 14 of hydrophobic venting material disposed between the ink chamber 12 and the passageways 13 therein to prevent flow of liquid ink through the passageways 13. The hydrophobic venting material may be a generally flat sheet of material as shown or may be a plug of material or any suitable shape so long as it permits air to freely pass therethrough but also prevents passage of ink to thereby prevent leakage of ink from the chamber 12. A presently preferred hydrophobic venting material is a porous plastic material sold under the trademark GORETEX by Gore, Inc. of Elkton, Maryland. Other materials believed suitable are porous polytetrafluoroethylene materials such as TEFLON (Trademark of Dupont Company).

Figures 3 and 4 show an embodiment like the embodiment of Fig. 1, but which is also provided with a vented wall 20 near the tip portion 4 of the pen. As shown, the vent wall 20 is planar and has a plurality of vent bores 22 therethrough arranged in circular pattern around the pen nib 6. An annular ring 24 of hydrophobic venting material is disposed inside the ink chamber 12 in tight engagement with the interior surface of the vent wall 20 whereby ink in the chamber is prevented from leaking between ring 24 and end wall 20 then through the vent bores 22 which are closed by the hydrophobic material. Regardless of the orientation of the pen, atmospheric venting of the ink chamber through the hydrophobic material and vents at the cap end or at the vent wall end of the ink chamber takes place without leakage of the pen.

Figure 5 shows a third embodiment of the invention similar to the embodiment of Fig. 1, but in which a conical plug 30 of hydrophobic venting material extends inwardly into the ink chamber 12 from the vent cap 10. Figure 5 is shown in inverted non-writing position with the liquid level L of the ink of the filled reservoir as shown slightly below the apex 32 of the conical plug 30 of hydrophobic material. The air in the ink chamber 12 of the Fig. 3, embodiment is thus permitted to pass back and forth to atmosphere through conical plug 30 of hydrophobic venting material regardless of the ori-

entation of the pen.

Figure 6 is a graph comparing ink flow characteristics of the present invention with those of filler reservoir pens of the prior art. As seen in the graph, the amount of ink delivered to the media gradually decreases as the ink supply is exhausted in prior art filler reservoir pens. In comparison, the amount of ink delivered to the paper or other media remains substantially constant regardless of the amount of ink which has been used for the free liquid ink vented pens of the invention.

Persons skilled in the art will readily appreciate that various modifications can be made from the preferred embodiment thus the scope of protection is intended to be defined only by the limitations of the appended claims.

Claims

1. A free liquid ink reservoir pen comprising:
 - a) a reservoir containing a supply of liquid ink;
 - b) a pen nib attached to said reservoir for delivering ink from said supply thereof to a writing medium;
 - c) a vent for venting said reservoir to atmosphere; and
 - d) a body of hydrophobic venting material arranged to prevent the flow of ink from said reservoir through said vent to atmosphere, said hydrophobic venting material permitting air flow into and out of said reservoir through said vent to compensate for pressure differentials between the ambient atmosphere and the interior of said reservoir.
2. The pen of claim 1, wherein said vent is located at an area of said reservoir remote from said nib.
3. The pen of claim 2, further comprising a second reservoir vent located at an area of said reservoir proximate said nib, and a second body of said hydrophobic venting material arranged to prevent flow of ink from said reservoir through said second vent to atmosphere.
4. The pen of claim 3, wherein said reservoir has a cylindrical portion and said nib is located at one end of said cylindrical portion.
5. The pen of claim 4, wherein said second vent comprises a plurality of conduits arranged in a circular pattern around said nib and said second body of hydrophobic material is of generally annular shape.
6. The pen of claim 1, wherein said reservoir is of generally cylindrical shape and has said nib at one end thereof and said body of hydrophobic venting material comprises a cone shaped plug which has its apex extending into said reservoir to provide air venting of said reservoir in any orientation of said reservoir.

7. The pen of claim 5, wherein said reservoir is of generally cylindrical shape and has said nib at one end thereof and said first body of hydrophobic venting material comprises a cone shaped plug which has its apex extending into said reservoir to provide air venting of said reservoir in any orientation of said reservoir.

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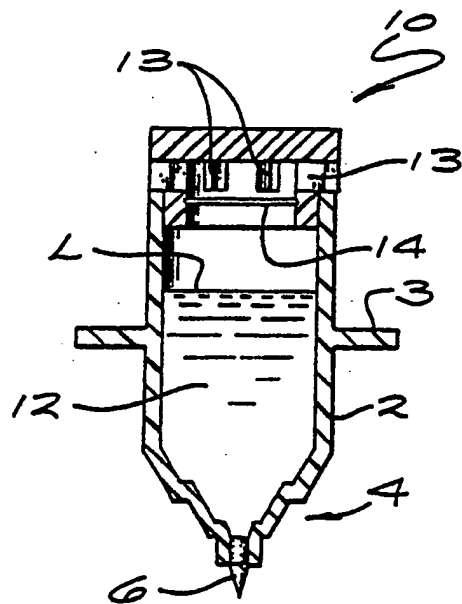


FIG. 1

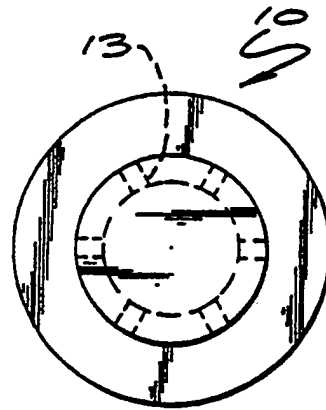


FIG. 2

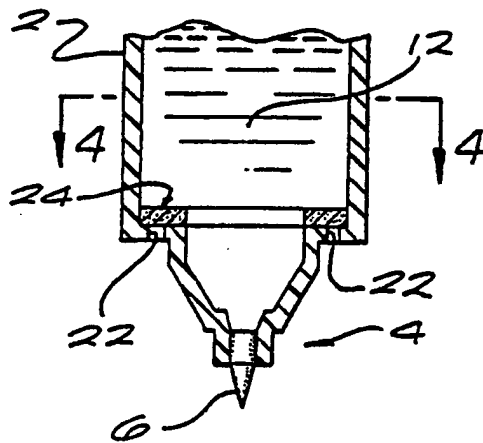


FIG. 3

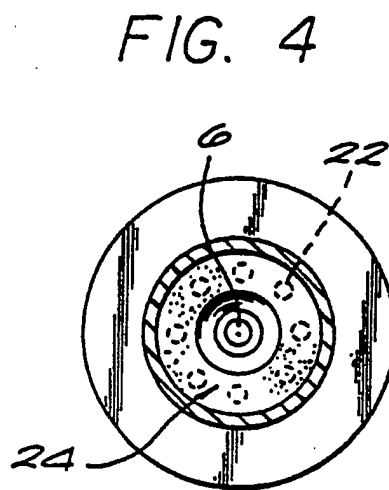


FIG. 4

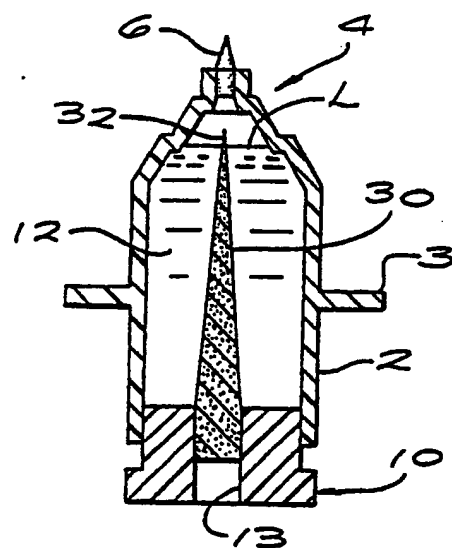


FIG. 5

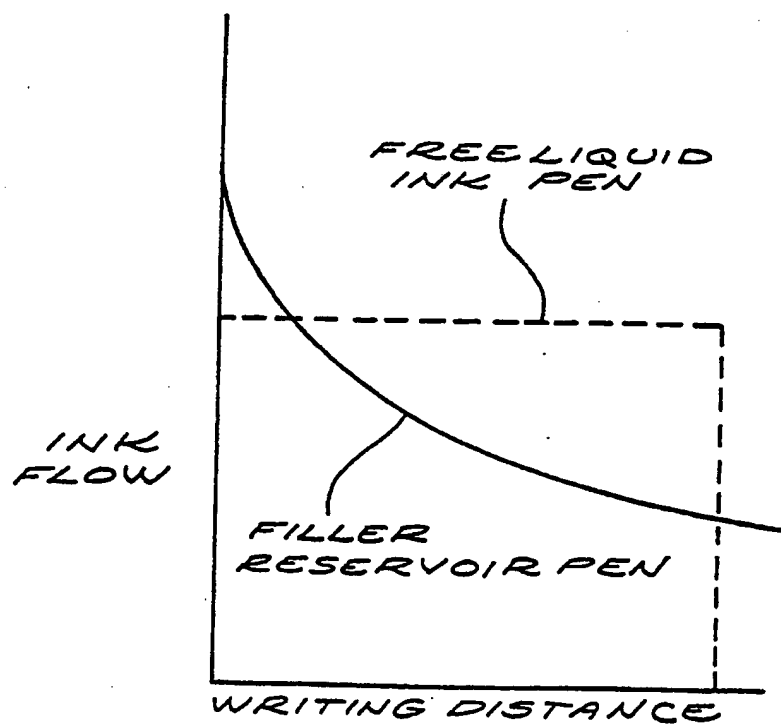


FIG. 6



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EUROPEAN SEARCH REPORT

Application Number

EP 90 30 6121

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	EP-A-210469 (MONTBLANC-SIMPLD) * page 9, last paragraph - page 10, paragraph 1; claims 1-13; figures 2-4 *	1-4	B43K5/02 B43K8/14 B43K8/02
A	----	5	
Y	EP-A-243922 (W.L. GORE & CO) * claims 1-11; figures 1, 2 *	1-4	
A, D	US-A-4588319 (NIEMEYER) * claims 1-17; figures 1-7 *	1, 2, 4	
A	CH-A-329410 (CRAYONS CARAN D'ACHE) * claims 1-5; figures 1-3 *	1, 2	
A	FR-A-2528361 (PARKER) * page 8, line 24 - page 9, line 15; figure 5 *	1, 3	
A	FR-E-60745 (YVINEC) * the whole document *	6, 7	
A	DE-C-232439 (BAUM) * the whole document *	6, 7	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			B43K
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 28 SEPTEMBER 1990	Examiner PERNEY Y.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application I : document cited for other reasons & : member of the same patent family, corresponding document	